[0009] However, with the above-described techniques, a knife or other mechanical instrument is generally used to form the channel, flap or pocket. Use of these instruments may result in damage or imprecision in the cut or formation of the desired area in which the implant is placed.

[0010] Furthermore, many of the steps of the above procedures are performed by hand. For example, the formation of the flap and the placing of the intraocular lens on the surface of the cornea are generally performed by the surgeon performing the operation. By performing these tasks by hand, there can be a relatively large margin of error in which the surgeon may improperly form the flap or improperly position the lens.

[0011] Additionally, many conventional excimer lasers are permanently or semi-permanently fixed, and the patient is positioned in front of the laser during the procedure. This restricts the work environment and can result in difficulties in obtaining the proper positioning of the patient.

[0012] Therefore, there exists a need for an improved, more versatile method of correcting refractive error in the cornea of an eye.

Summary of the Invention

[0013] Accordingly, it is an object of the present invention to provide an improved, more versatile method of correcting refractive error in the cornea of an eye.

[0014] Another object of the present invention is to provide a system and method for modifying the cornea of an eye that results in a precise separation between layers in the cornea.

[0015] Still another object of the present invention is to provide a system and method for modifying the cornea of an eye that allows for corrective measures that avoid or eliminate outbulging or instability in the cornea.

[0016] Yet another object of the present invention is to provide a system and method for modifying the cornea of an eye that avoids or eliminates most of the risks of damage due to the use of knives or other mechanical instruments.

[0017] Yet another object of the present invention is to provide a system and method for modifying the cornea of the eye that eliminates or reduces the margin for error by using robotic arms to perform many of the manual functions.

[0018] The foregoing objects are basically attained by a method for correcting the refractive error in the cornea of the eye by separating a layer of the cornea into first and second internal surfaces, the first surface facing in a posterior direction and the second surface facing in an anterior direction. An intracorneal lens is then ablated, while being retained by a robotic arm, and then the robotic arm inserts the intracorneal lens proximate to at least one of the first and second internal surfaces.

[0019] The foregoing objects are further attained by a method for correcting refractive error in a cornea of an eye by aiming and firing an ultrashort pulse laser at the cornea of the eye using a first automated device. The laser forms a flap thereon, which is moved to expose first and second intracorneal surfaces. An intracorneal lens is then positioned on the second internal corneal surface using a second automated device. An excimer laser is aimed and fired at the intracorneal lensing using a third automated device, ablating a portion thereof. The flap is then replaced over the intracorneal lens and the exterior surface of the cornea is compressed. A contact is applied to the exterior surface of the eye to protect the flap.

[0020] The foregoing objects are further attained by a system for correcting the refractive error in the cornea of an eye of a patient, the cornea having an external surface and the eye having a main optical axis. The system has a first robotic arm adapted to be positioned relative to the cornea. An ultrashort pulse laser is coupled to the first robotic arm and adapted to separate a layer of the cornea into first and second internal surfaces. A second robotic arm is adapted to be positioned relative to the cornea and a lens dispensing device is coupled to the second robotic arm and adapted to position a lens on the second internal surface of the cornea. A third robotic arm is adapted to be positioned relative to the cornea and a second laser is coupled to the third robotic arm and adapted to ablate a portion of the lens.

[0021] Other objects, advantages, and salient features of the present invention will become apparent to those skilled in the art from the following detailed description,

which, taken in conjunction with the annexed drawings, discloses preferred embodiments of the invention.

Brief Description of the Drawings

[0022] Referring to the drawings which form a part of this disclosure:

[0023] Fig. 1 illustrates a system for correcting refractive error in the cornea of the eye, according to an embodiment of the present invention;

[0024] Fig. 2 is a top perspective view of a robotic arm with a excimer laser coupled thereto;

[0025] Fig. 3 is a top perspective view of a robotic arm with a ultrashort pulse laser coupled thereto;

[0026] Fig. 4 is a bottom perspective view of a robotic arm with the lens dispensing device of Fig. 9 coupled thereto;

[0027] Fig. 5 is a side cross-sectional view of the eye of a patient with a corneal flap formed in the cornea of the eye by irradiating the cornea with an ultrashort pulse laser;

[0028] Fig. 6 is front elevational view of an internal corneal surface of the cornea with a mark in the shape of a dot aligned with the optical axis;

[0029] Fig. 7 is front elevational view of an internal corneal surface of the cornea with a mark in the shape of a "plus" aligned with the optical axis;

[0030] Fig. 8 is a side cross-sectional view of an intracorneal lens positioned on an exposed internal corneal surface of the eye of Fig. 5;

[0031] Fig. 9 is a side cross-sectional view of a lens dispensing device with intracorneal lenses inserted therein;

[0032] Fig. 10 is front elevational view of an intracorneal lens with a mark in the shape of a dot aligned with the central axis of the lens;

[0033] Fig. 11 is front elevational view of an intracorneal lens with a mark in the shape of a "plus" aligned with the central axis of the lens;

[0034] Fig. 12 is a side cross-sectional view of a laser ablating a portion of the intracorneal lens of Fig. 8;